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THE EUROPEAN EARWIG [1] AND ITS CONTROL.

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The European earwig (fig. 1) was first noted at Newport, R. I., in 1911 and is now present there in vast numbers. While it is not

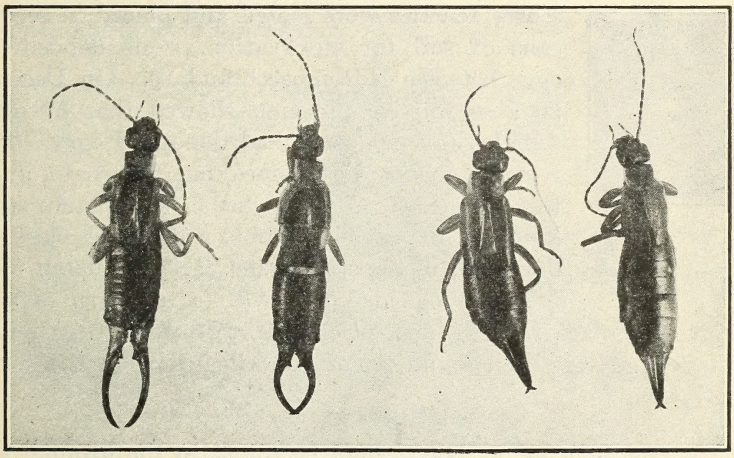

FIG. 1.—The European earwig (*Forficula auricularia*): Adult males at left, adult females at right. (Original.)

considered of great economic importance in Europe, it has increased so rapidly in Newport that it has become a serious pest and caused

[1] *Forficula auricularia* L.

NOTE.—The first visit to Newport to study the habits of this insect was made by the writer in August, 1915. Eight trips of this kind, averaging four days each, were made during the summer and fall. Work was resumed May 6, 1916, and experiments were under close observation through the entire season. Mr. T. Suffern Tailer, a resident of Newport, whose grounds are in the heart of the area infested by this insect, gave financial support to cover expenses of the control measures and furnished the writer a large room to be used as a laboratory. With his cooperation and the help of his head gardener, Mr. William Edward, many facilities for the study of this insect were provided. Cooperation was also secured from other owners and gardeners, and Mr. Perez Simmons, a graduate of the Massachusetts Agricultural College, assisted in the application of control measures. The photographs used were made by Mr. Harold A. Preston of the Gipsy Moth Laboratory.

much annoyance. It is not unreasonable to suppose that this insect will spread to other sections of the country and cause great annoyance to farmers.

A much smaller colony, which, however, has increased rapidly, was reported from Seattle, Wash., in 1915. Other reports of the occurrence of this earwig in the United States appear to have originated from one or two cases in which isolated specimens were captured on imported plants.

This earwig is found all over Europe, but is seldom present in extreme numbers. It is impossible to say from which of the European countries the colony at Newport originated, or how the first individuals were imported. Quantities of nursery stock arrive from abroad each year upon which the importation may have been made.

DESCRIPTION AND SEASONAL HISTORY.[1]

THE EGG.

The female earwig lays from 50 to 90 shining white eggs (fig. 2) in the ground, the eggs being about one-twentieth inch in length. Forty females were mated and placed in separate cans of soil for observation. One deposited 82 eggs between November 6 and 10. On December 26 a second examination showed that 30 of the females (75 per cent) had deposited eggs. These females do not die at once, but hibernate, and in the spring attend the larvæ in their early stages. During the previous year in a few cases eggs were deposited in the spring, but failed to hatch.

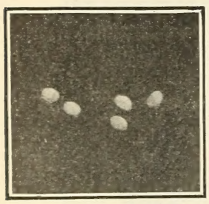

FIG. 2.—Eggs of European earwig. Enlarged twice. (Original.)

Mellow garden soil with a southern exposure is a favorite place for egg deposition. Many hibernating females and their eggs have been found from 2 to 3 inches below the surface of the lawns.

THE LARVA STAGES.

The young earwigs, or larvæ, may be found in the ground, or at night on the soil surface, about May 5. They resemble the adults in general form, but have no wings and only delicate, simple forceps or pinchers on the posterior extremity of the body. At first they are pure white, but the color slowly darkens to a delicate olive green which has a peculiar shiny appearance. About June 9 they appear very dusky olive green, or even steel gray, with almost transparent

[1] The season during which these notes were gathered was rather peculiar. The entire spring was so cold and wet that foliage and insects were retarded in their development approximately one week. The summer was nearly normal, but was followed by a long dry fall. No killing frost occurred until the second week in November, and no real freezing of the soil took place until after December 1. The larval development in an ordinary season would be approximately one week ahead of the dates given for 1916, while the fall dates for hibernation and egg deposition usually would be from one to four weeks ahead of those in 1916.

legs and a dull-brown head (fig. 3). There are four larva stages which gradually approach the adult in size and color. The change from the fourth larva stage to the adult form takes place about July 18.

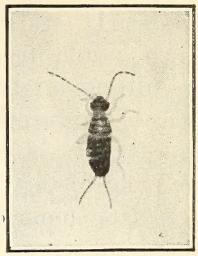

FIG. 3. — Larva of European earwig. Enlarged twice. (Original.)

When first hatched the larvæ leave their underground nests, most noticeably on warm nights about two hours after dark. They swarm over the ground, but usually stay within 2 or 3 feet of the entrance to their nest. On cold nights few can be found. As they grow older they are active even on cold, wet nights.

Young larvæ feed on very tender green shoots such as clover and grass, and possibly portions of grass roots. Later they feed extensively on green shoots such as Lima-bean (fig. 4) or dahlia plants (fig. 5 in comparison with fig. 6). By July 1 dahlia buds begin to appear and the blossoms of sweet William and early roses are plentiful. These are damaged greatly by the young earwigs. The bases of the petals and the stamens are eaten and the old taste for green shoots disappears if favorable flowers are near.

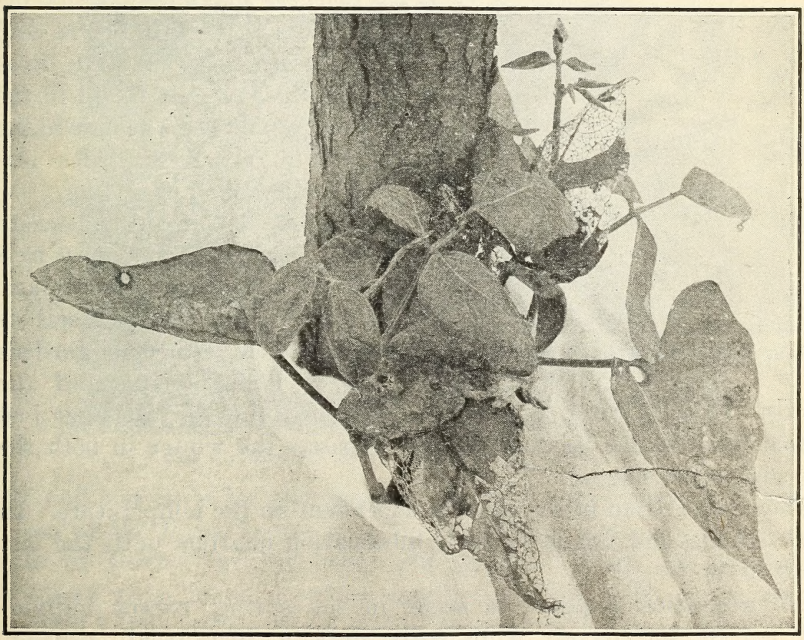

FIG. 4.—Lima bean plant partially eaten by young earwigs. (Original.)

THE ADULT.

The adult is rich reddish brown, with the wing covers and legs dull yellow brown, and the wings completely developed. From head

to tip of forceps it is about three-fourths of an inch in length. The forceps of the male are curved into a semicircle, or slightly elongated, with a tooth at the point of divergence. In the female the forceps are nearly straight.

The adults feed almost entirely on the petals and stamens of flowers, although many other kinds of food, such as clover, grass, terminal buds of chrysanthemums, and other fall flowers, are eaten. They kill and eat certain unprotected, sluggish larvæ, dead flies, and the dead or dying of their own species.

In late summer the adults congregate in large numbers in crevices or behind vines (fig. 7), near a good food supply. This concentration of large numbers of earwigs in favorable hiding places is due entirely to the mating instinct.

FIG. 5.—Dahlia plant defoliated by young earwigs. (Original.)

HIBERNATION.

Adult males seldom live over winter in Newport, R. I. Nearly all of them die after copulation, which occurs in the fall, before cold weather sets in. An occasional male is found in the ground with a female in the late fall; these males usually die before spring.

Adult females hibernate in the ground from 2 to 8 inches below the surface. Any well-drained soil is suitable, either in gardens or under the sod of the lawns. In some cases, as has been explained, they deposit eggs just before hibernating, so that this insect passes the winter in both the egg and adult stages.

Emergence from hibernation is dependent on the temperature. In 1916 females did not leave their hibernation quarters until the last week in April.

No migration appears to occur in the spring, except individual search for food. Apparently only a very small percentage of the total number of adult females is able to live over winter successfully.

DISAGREEABLE HABITS OF CONCEALMENT.

The adult earwigs hide very quickly if disturbed by a sudden light or some unusual noise. During the day they hide in any crevice, fold of clothing, or even behind a convenient leaf which offers protection. Thus one finds them in large numbers on the porches, behind the chair cushions, under the rugs, and in folds of awnings. On one estate, each morning when the porch awnings were let down, over a quart of earwigs dropped out and were swept up and burned. The writer has seen at least 300 adult earwigs in one of the servants' halls at Newport. They were behind the cushions in the chairs, in

FIG. 6.—Normal, uneaten dahlia plant. (Original.)

folds of lace curtains, and even on the table. Bedrooms and bathrooms of the finest houses may be invaded by occasional adults in spite of careful watchfulness and screens. They are decidedly repulsive when found crawling rapidly over the walls or furniture at night. The stories about bodily harm done by these insects are all without foundation.

AREA INFESTED.

The evidence at hand regarding the area infested previous to 1914 is very meager. It consists of data drawn from conversations with

gardeners of the various estates. In almost every case they are men of education and trained powers of observation.

1911.—Mr. T. Suffern Tailer owns the estate where the first earwigs were noted. His gardener believes that a very few were present in 1911.

1912.—Mr. Tailer and his gardener state definitely that earwigs were present in 1912. Specimens were sent to Washington, D. C., by Dr. A. E. Stene, of the Rhode Island State College.

1913.—The infestation in 1913 had spread to adjoining estates. Large numbers were found on Mr. Tailer's estate and his men attempted certain control measures.

FIG. 7.—A typical congregating place for adult earwigs. (Original.)

1914.—About 1 square mile was heavily infested in 1914. Mr. Richard Gardener, of Newport, wrote to the Bureau of Entomology at Washington, asking for information regarding the insect.

1915.—The infestation during 1915 was so heavy that letters requesting information about methods of control were sent to Washington and to the State college at Kingston, R. I. A careful scouting conducted by the writer showed that about 9 square miles were heavily infested. This area is bounded on three sides by water. On the fourth side, 2 miles of territory in addition to that infested in 1915 had small scattered colonies. One isolated colony was located

about 6½ miles northeast of this infested area, on the estate of the late Alfred Gwynn Vanderbilt, of Portsmouth.

1916.—About 10 square miles were heavily infested in 1916 and many new small colonies were found outside of this area. The small colonies of the previous year showed considerable growth. In some cases hundreds of earwigs were present on estates where only a few were found the year before.

METHODS OF DISPERSION.

This species rarely if ever spreads by flight; in fact, experimental efforts to induce these insects to use their delicate and complex wings were unsuccessful.

Many cases have been noticed where adult earwigs have been carried long distances in folds of clothing. Visitors to Newport may spread the insect to near-by cities in this way. Several isolated colonies located at a distance from the main infestation are at points where automobiles frequently stop while their owners walk about the extensive grounds.

These insects may be spread while hiding in the packing material or the soil of shipments of plants and general nursery stock. One dead specimen was found by J. J. Pillsbury, assistant State entomologist of Rhode Island, in a shipment of plants from Holland. The writer has noted these insects in the fall between the toes of dahlia bulbs.

NATURAL ENEMIES.

A parasitic, threadlike worm has caused the death of approximately 10 per cent of the earwig larvæ under close observation in the laboratory. This worm[1] lives free in the body cavity of full-grown larval and adult earwigs. The average measurements of five of these parasites was 3¼ inches by $\frac{1}{48}$ inch.

Various other parasites are reported as having been reared from this species of earwig in Europe, but at Newport those so far dissected have been free from parasites except in the case of one small unidentified larva and the worm just referred to.

Toads eat earwig larvæ readily, but are not common at Newport.

Hens devour adult earwigs ravenously. One hen ate 10 of these insects thrown to her in as many seconds. Under natural conditions these insects are hidden away so carefully through the day that fowls can hardly be considered as economically important in the sense of controlling the insect.

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[1] *Filaria locustae.*

CONTROL OF THE EARWIG.

NEED FOR SPECIAL CONTROL MEASURES.

In Europe this insect appears to be held in check by parasites and other natural agencies, and it is very rarely present in large numbers. Gardeners who raise prize dahlias, chrysanthemums, and flowers of that class are the only ones who consider the earwig an actual pest. As a result control measures have developed slowly. Their aim has been simply to protect a small area from the depredations of a comparatively small number of earwigs. Various methods of trapping have been developed which satisfy the need, so no better methods have been worked out.

At Newport, as has been stated, this insect occurs in vast numbers. The lack of parasites and other natural enemies, together with the favorable conditions met with at every stage of the life history, has made this rapid increase possible.

The control measures offered in this paper have been developed through laboratory tests and later have been tested in field trials on a large scale.

POISONED BAIT.

For early spring control, May 15 to June 15, poisoned-bread bait has proved extremely effective. In fact, it gave far better results than any other mixture that was tried. This method would prove cumbersome and expensive for the average farmer, but its extreme effectiveness makes it the best to recommend at this time. Stale bread was secured in 1916 for approximately 2 cents per pound. The bait is prepared as follows:

Stale white bread	pounds	16
Paris green	pound	1
Water.		

Grind the bread up fine in a meat-chopping machine and mix the Paris green with it while dry. Stir the mixture thoroughly, slowly adding water enough to make a mixture which will run through the fingers, and one which, when thrown broadcast with some force, will break up into small particles. The addition of cheap honey to the mixture increases its effectiveness, but is not necessary.

This bait should be spread broadcast between dusk and 9 p. m. in gardens and on lawns near vines and shrubs. It should be thrown with considerable force in order to break the bait up into smaller pieces. If the infestation is heavy or was heavy the previous year, three applications covering about 10 days may be necessary. Warm evenings should be selected if possible, as on such nights the larvæ are more active.

SONG BIRDS AND THE POISONED-BREAD BAIT.

The danger to song birds from the poisoned bread is very slight in the spring. After the 1st of July, especially in dry seasons when worms are not plentiful, this danger probably would increase. On May 11 an attempt was made to see if song birds would feed on this poisoned-bread bait. A narrow, recently spaded garden was selected which was south of a small greenhouse and east of a high privet hedge, where various birds were plentiful. Bits of this poisoned bait, the size of a pea, were placed 2 feet apart and 4 inches from the grass border, around the entire edge of the garden. The next morning the writer seated himself inside the greenhouse before daylight and watched the birds from 3.15 until 5.45 a. m. Ten robins were noted hopping along parallel to or crossing the lines of bait. They confined themselves entirely to feeding on earthworms. A pair of chipping sparrows were feeding on the soil surface nearly all the time, and a pair of purple grackles stalked across the lines of poisoned bait. In no case did these birds pay the slightest attention to the conspicuous bits of green bread, and after two days none of the particles were missing. No such experiment was tried in the late summer when worms were less plentiful. Probably it would be dangerous to use this mixture on ground where hens had free range.

POISON SPRAYS.

Poison sprays are not effective after July 1 because of the habit developed by this insect of feeding on protected parts of flowers and the very new shoots of various plants. During the early stages, when larvæ concentrate their feeding on certain varieties of plants, these plants should be sprayed with arsenate of lead, 6 pounds to 50 gallons of water, care being taken that the young leaves especially are covered.

As this insect is known to feed somewhat on grass and clover it might be advisable to spray infested portions of lawns carefully with arsenate of lead, but more tests are necessary to show the effectiveness of this treatment.

CONTACT SPRAYS.

Contact sprays which would burn foliage or would be objectionable near the houses on account of their odor were discarded. Any spray used on plants when they are in full bloom tends to make the petals of the blossoms fall. A contact spray which has given very good results in experimental work at Newport is made as follows:

Soft potash soap	ounces	30
Water	do	96
Nicotine sulphate, 40 per cent	teaspoonfuls	20

Dissolve the soap in a little of the water over a fire, then add the rest of the water and the nicotine sulphate. This makes 1 gallon of stock solution at an approximate cost of 50 cents. Use 1 part to 22 of water.

Common laundry soap	pound	½
Water	gallons	4
Nicotine sulphate, 40 per cent	teaspoonfuls	5

The soap must be shaved fine and dissolved in about one-third of the water, then the rest of the water and the nicotine sulphate are added. This mixture is applied without further dilution and is therefore practical only on a small scale. It does not give as good

FIG. 8.—Flowerpot traps for earwigs. Shorter supporting stakes proved to be of advantage. (Original.)

results as that containing potash soap. Fish-oil soap also was tried in this formula but burned foliage after several applications.

The foregoing two, being contact sprays, must actually hit the insects and hit them well or death is not assured. For this reason thorough spraying must be done at night, the insects being hit with a *fine mist* as they crawl over the plants, vines, and grass. To supplement this night spraying it is well to treat with a stream of the same material any crevices where insects are plentiful through the day. If necessary, the spraying of heavily infested areas should be repeated at intervals of three nights until the results are satisfactory.

TRAPPING.

Trapping is the chief method of control recommended by European authorities. The best trap (fig. 8) appears to be a 3-inch

flowerpot, with excelsior in the bottom, inverted over a 9-inch stick set in the ground close to plants or vines where earwigs are most numerous. The earwigs hide in the excelsior and should be shaken into a pail of water which has a thin film of kerosene oil on its surface. Pieces of bamboo, piles of straw, strawberry boxes, and in fact anything that offers shelter may be used; but these substitutes are either less effective or less easily handled than flowerpot traps.

MISCELLANEOUS.

In cases of extreme abundance earwigs may be kept from a porch by surrounding the porch completely with a 1-inch band of a suitable sticky substance. This sticky material prevents the invasion of earwigs unless some crevice exists under the band or some vine furnishes a bridge over it. To be effective this material should be applied by June 15, and its surface must be brushed over with a wire brush by July 15, and possibly once more during the season.

EFFICIENCY OF CONTROL MEASURES.

Experiments in the field with poisoned-bread bait in May were on a rather small scale. Several flower beds and small isolated lawns which were literally swarming with young earwigs were treated with this bait. The results were surprising. Very nearly 100 per cent of the larvæ were killed with one application of bait in each case.

Five estates were partially treated with this bait on June 22, 1916, and again three days later. The young earwigs at that time were passing rapidly into the fourth stage. As has been stated, the habits rapidly become similar to those of the adult. At this late date flowers such as sweet William and roses furnished food, and many of the earwigs had left their nests in the ground. Thus they were harder to reach with the poisoned-bread bait. It is estimated that over 75 per cent of the larvæ on these five estates were killed by these two late applications of bait. Far better results could be expected earlier in the season on favorable nights.

Spraying with contact sprays at night was done on a large scale after July 1. Mr. Simmons and an assistant used a barrel pump for this work, equipped with a Bordeaux nozzle. They planned to spray every three nights the same area, namely, the vines near the houses, and a 10-foot circle of lawn around each house. In this way the houses were kept free from the insect. This spraying was continued for over a month, although far less than 1 per cent of the usual number of earwigs could be found on these estates after July 20. A few continued to crawl in from surrounding estates, especially late in the fall.

Six flowerpot traps were placed near some dahlia plants throughout the season. These gave good results; but they are valuable only where the earwigs are scarce. They take care of the "crawl-in" after a garden has been treated with poisoned bait and contact spray.

Sticky substance was applied around the porches of one house. This is necessary only in extreme cases where no control measures have been applied and adult earwigs are causing annoyance in the houses.

SUMMARY OF RECOMMENDATIONS FOR CONTROL.

MAY 15 TO JUNE 15.

Spread poisoned-bread bait broadcast over the lawns and gardens. Select a warm evening about May 15 and apply the bait just before dark. Give one or two more applications of this bait at intervals of three or four nights.

Spray plants which show signs of having been eaten, using 6 pounds of arsenate of lead to 50 gallons of water, and being very careful to cover the young leaves with the spray.

AFTER JULY 1.

If the earwig has not been controlled in the spring, spray at night with a contact spray, covering the insects well as they crawl over the grass and plants. Repeat every three nights until the numbers are sufficiently reduced.

To supplement the night spraying look for crevices where earwigs commonly hide through the day. Squirt contact spray into these cracks every other day.

Place flowerpot traps every 10 or 12 feet along borders or near vines. Remove earwigs from the traps each day by shaking the excelsior over a pail of kerosene and water.

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